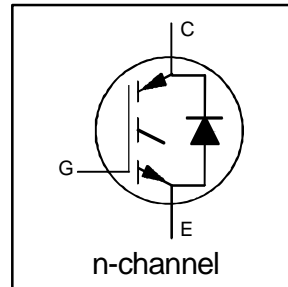


**INSULATED GATE BIPOLAR TRANSISTOR
WITH ULTRAFAST SOFT RECOVERY**

Fast CoPack IGBT

**DIODE
Features**

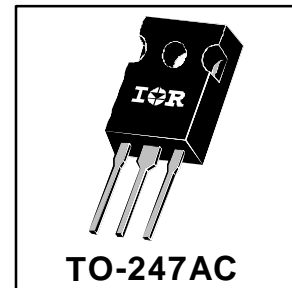
- Switching-loss rating includes all "tail" losses
- HEXFRED™ soft ultrafast diodes
- Optimized for medium operating frequency (1 to 10kHz) See Fig. 1 for Current vs. Frequency curve



$V_{CES} = 600V$
 $V_{CE(sat)} \leq 2.0V$
@ $V_{GE} = 15V, I_C = 27A$

Description

Co-packaged IGBTs are a natural extension of International Rectifier's well known IGBT line. They provide the convenience of an IGBT and an ultrafast recovery diode in one package, resulting in substantial benefits to a host of high-voltage, high-current, motor control, UPS and power supply applications.



Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---------------------------|------------------------------------|-----------------------------------|-------|
| V_{CES} | Collector-to-Emitter Voltage | 600 | V |
| $I_C @ T_C = 25^\circ C$ | Continuous Collector Current | 49 | A |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current | 27 | |
| I_{CM} | Pulsed Collector Current ① | 200 | |
| I_{LM} | Clamped Inductive Load Current ② | 200 | |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current | 15 | |
| I_{FM} | Diode Maximum Forward Current | 200 | |
| V_{GE} | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D @ T_C = 25^\circ C$ | Maximum Power Dissipation | 160 | W |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation | 65 | |
| T_J | Operating Junction and | -55 to +150 | °C |
| T_{STG} | Storage Temperature Range | | |
| | Soldering Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |
| | Mounting Torque, 6-32 or M3 Screw. | 10 lbf•in (1.1 N•m) | |

Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|-----------------|---|------|----------|------|--------|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | — | — | 0.77 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | — | — | 1.7 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | — | 0.24 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | — | — | 40 | |
| Wt | Weight | — | 6 (0.21) | — | g (oz) |

IRGPC40FD2



Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---------------------------------|--|------|------|-----------|---------------------|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage ③ | 600 | — | — | V | $V_{GE} = 0V, I_C = 250\mu A$ |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temp. Coeff. of Breakdown Voltage | — | 0.70 | — | $V/^\circ\text{C}$ | $V_{GE} = 0V, I_C = 1.0mA$ |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.7 | 2.0 | V | $I_C = 27A$ $I_C = 49A$ $I_C = 27A, T_J = 150^\circ\text{C}$ $V_{GE} = 15V$ See Fig. 2, 5 |
| | | — | 2.2 | — | | |
| | | — | 1.9 | — | | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.5 | | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| $\Delta V_{GE(th)}/\Delta T_J$ | Temp. Coeff. of Threshold Voltage | — | -12 | — | $mV/^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| g_{fe} | Forward Transconductance ④ | 9.2 | 12 | — | S | $V_{CE} = 100V, I_C = 27A$ |
| I_{CES} | Zero Gate Voltage Collector Current | — | — | 250 | μA | $V_{GE} = 0V, V_{CE} = 600V$ $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| | | — | — | 3500 | | |
| V_{FM} | Diode Forward Voltage Drop | — | 1.3 | 1.7 | V | $I_C = 15A$ $I_C = 15A, T_J = 150^\circ\text{C}$ See Fig. 13 |
| | | — | 1.2 | 1.6 | | |
| I_{GES} | Gate-to-Emitter Leakage Current | — | — | ± 100 | nA | $V_{GE} = \pm 20V$ |

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|------------------|--|------|------|------|-----------|--|
| Q_g | Total Gate Charge (turn-on) | — | 59 | 80 | nC | $I_C = 27A$ $V_{CC} = 400V$ See Fig. 8 |
| Q_{ge} | Gate - Emitter Charge (turn-on) | — | 8.6 | 10 | | |
| Q_{gc} | Gate - Collector Charge (turn-on) | — | 25 | 42 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 71 | — | ns | $T_J = 25^\circ\text{C}$ $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18 |
| t_r | Rise Time | — | 76 | — | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 320 | 480 | | |
| t_f | Fall Time | — | 210 | 320 | | |
| E_{on} | Turn-On Switching Loss | — | 1.3 | — | | |
| E_{off} | Turn-Off Switching Loss | — | 3.2 | — | mJ | See Fig. 9, 10, 11, 18 |
| E_{ts} | Total Switching Loss | — | 4.5 | 6.8 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 70 | — | ns | $T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18 $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery. |
| t_r | Rise Time | — | 73 | — | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 540 | — | | |
| t_f | Fall Time | — | 480 | — | | |
| E_{ts} | Total Switching Loss | — | 7.8 | — | | |
| L_E | Internal Emitter Inductance | — | 13 | — | nH | Measured 5mm from package |
| C_{ies} | Input Capacitance | — | 1500 | — | pF | $V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ See Fig. 7 |
| C_{oes} | Output Capacitance | — | 190 | — | | |
| C_{res} | Reverse Transfer Capacitance | — | 20 | — | | |
| t_{rr} | Diode Reverse Recovery Time | — | 42 | 60 | ns | $T_J = 25^\circ\text{C}$ See Fig. 14 $T_J = 125^\circ\text{C}$ 14 |
| | | — | 74 | 120 | | |
| I_{rr} | Diode Peak Reverse Recovery Current | — | 4.0 | 6.0 | A | $T_J = 25^\circ\text{C}$ See Fig. 15 $T_J = 125^\circ\text{C}$ 15 |
| | | — | 6.5 | 10 | | |
| Q_{rr} | Diode Reverse Recovery Charge | — | 80 | 180 | nC | $T_J = 25^\circ\text{C}$ See Fig. 16 $T_J = 125^\circ\text{C}$ 16 |
| | | — | 220 | 600 | | |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During t_b | — | 188 | — | $A/\mu s$ | $T_J = 25^\circ\text{C}$ See Fig. 17 $T_J = 125^\circ\text{C}$ 17 |
| | | — | 160 | — | | |

Notes:

① Repetitive rating; $V_{GE}=20V$, pulse width limited by max. junction temperature. (See fig. 20)

② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G=10\Omega$, (See fig. 19)

③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.

④ Pulse width $5.0\mu s$, single shot.

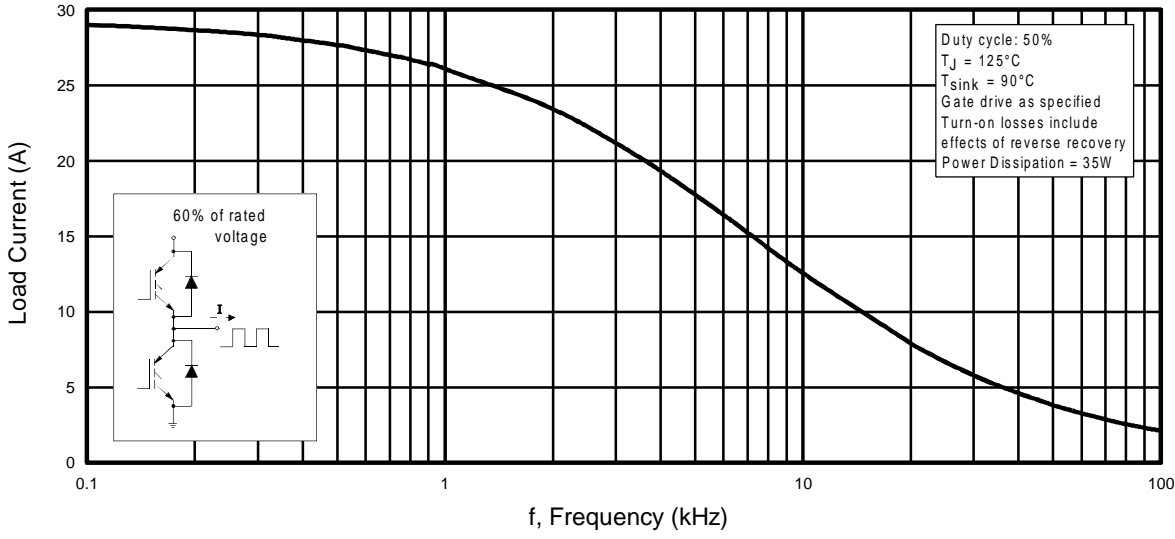


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

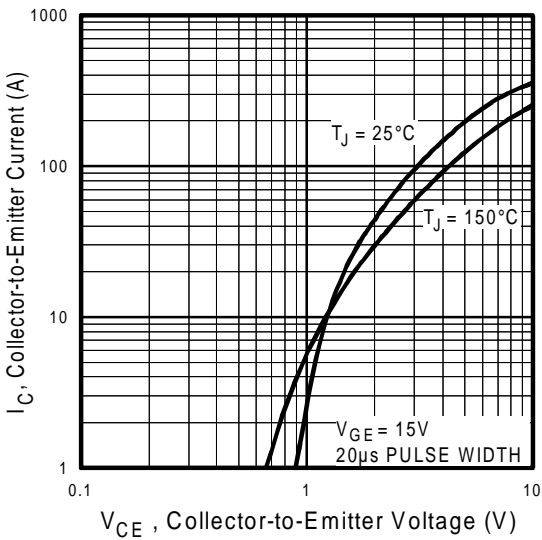


Fig. 2 - Typical Output Characteristics

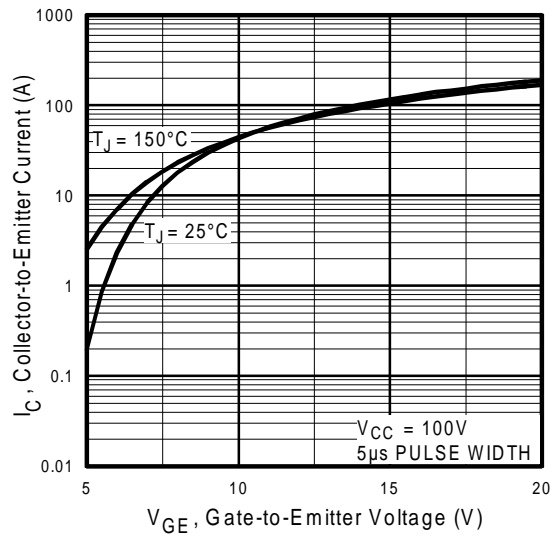


Fig. 3 - Typical Transfer Characteristics

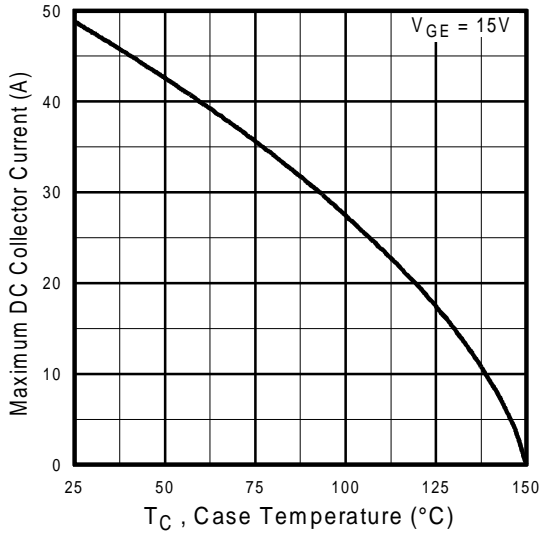


Fig. 4 - Maximum Collector Current vs. Case Temperature

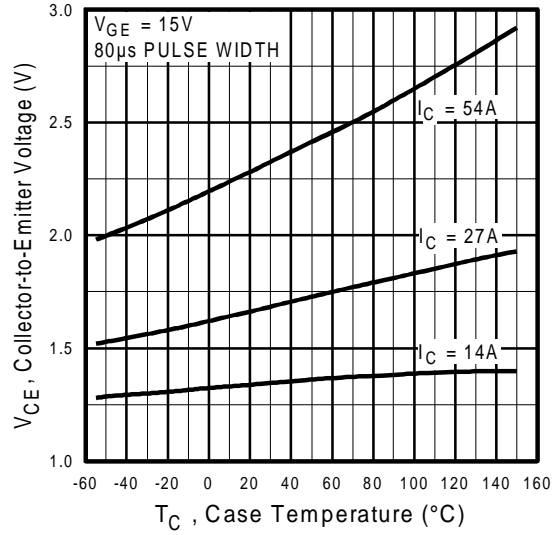


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

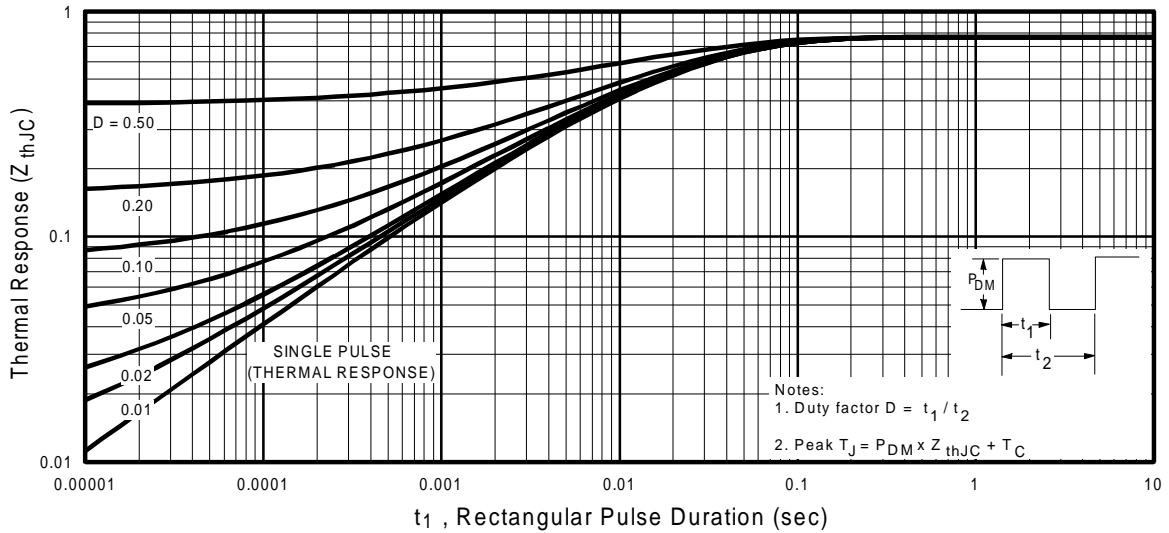


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

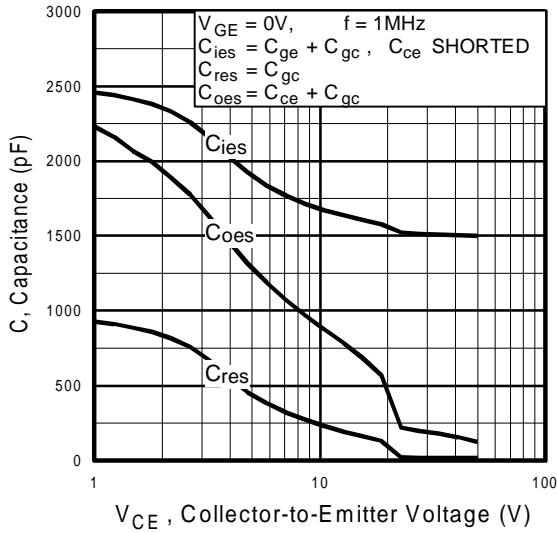


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

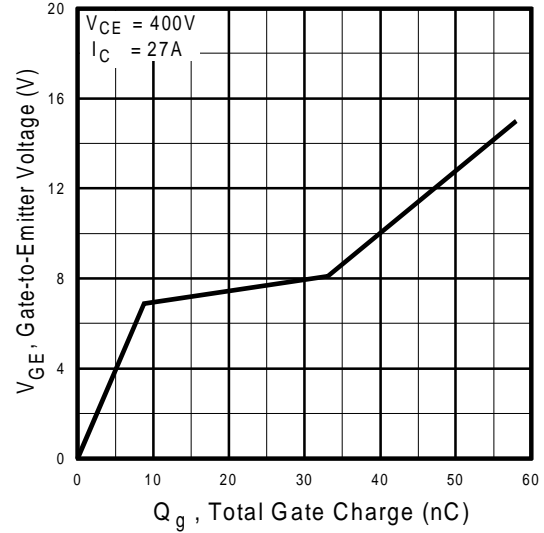


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

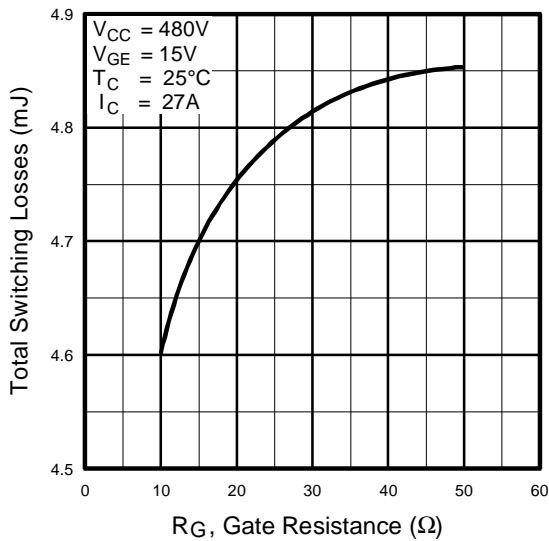


Fig. 9 - Typical Switching Losses vs. Gate Resistance

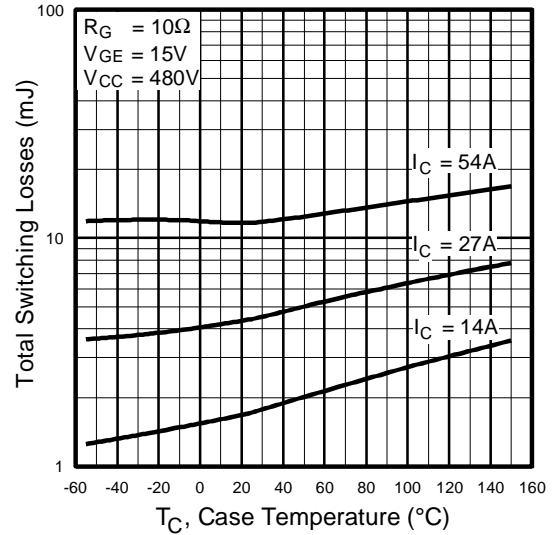


Fig. 10 - Typical Switching Losses vs. Case Temperature

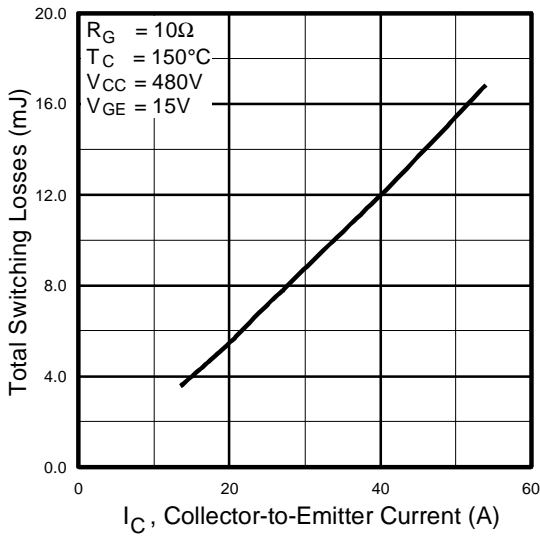


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

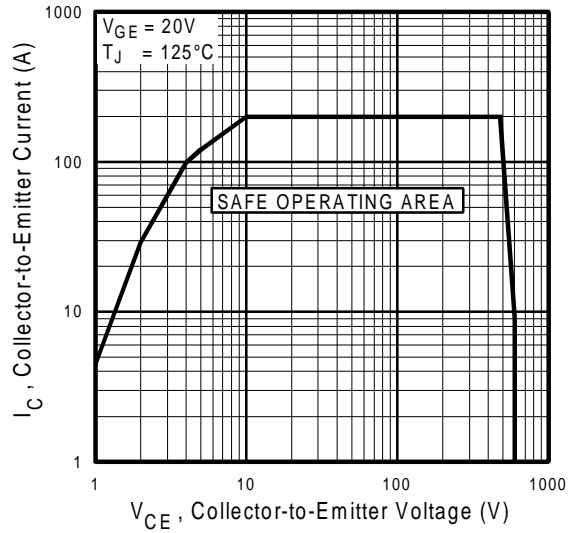


Fig. 12 - Turn-Off SOA

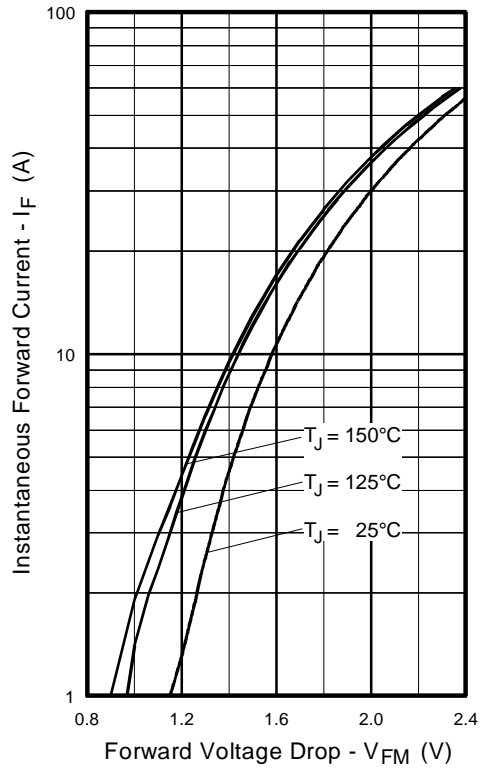


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

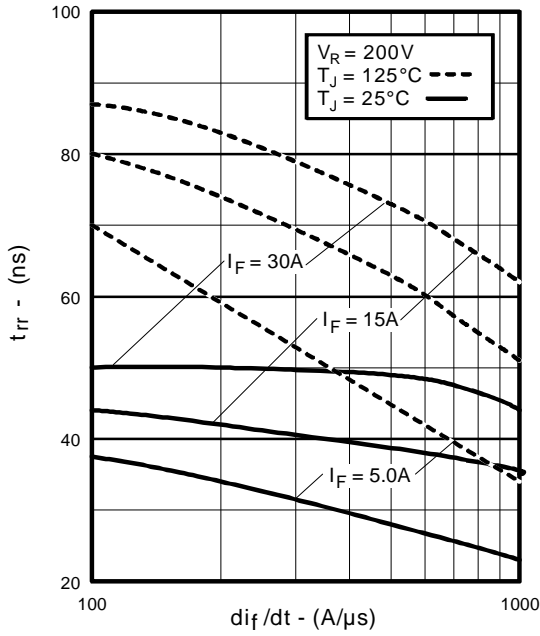


Fig. 14 - Typical Reverse Recovery vs. di/dt

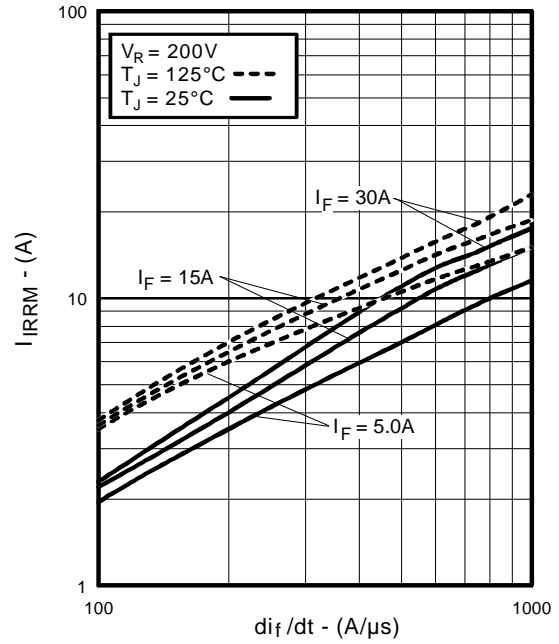


Fig. 15 - Typical Recovery Current vs. di/dt

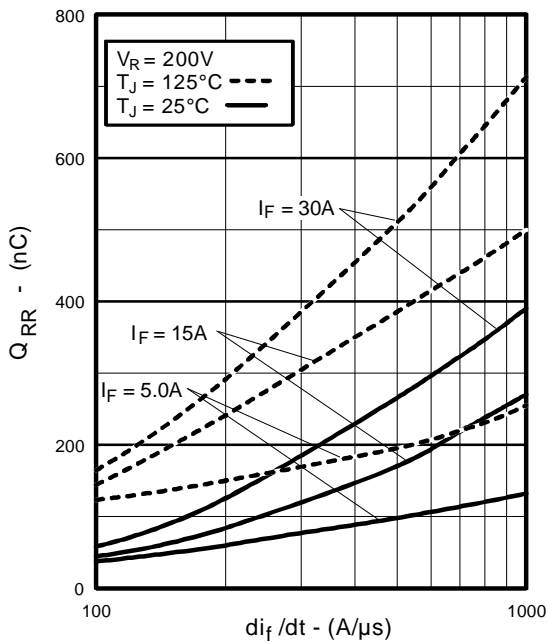


Fig. 16 - Typical Stored Charge vs. di/dt

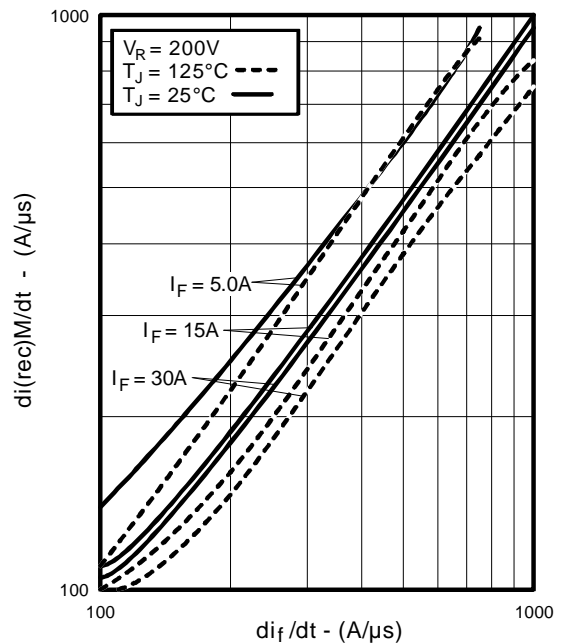


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di/dt

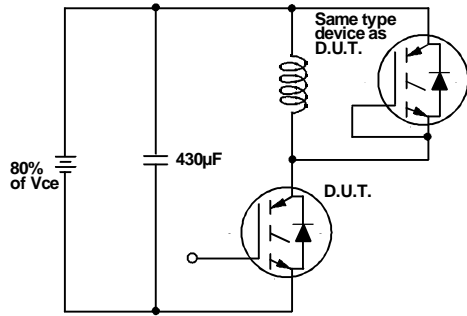


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

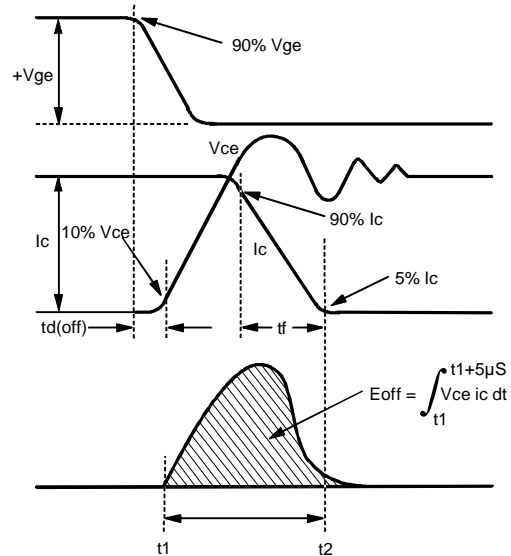


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

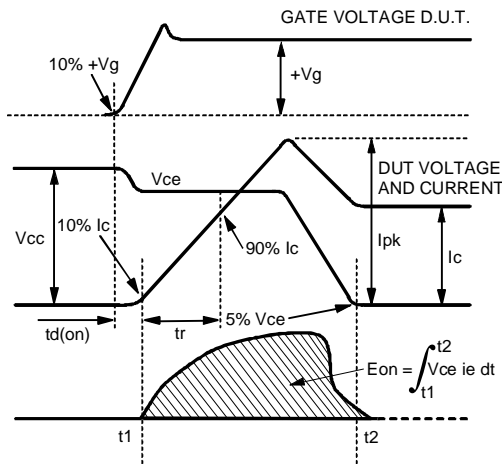


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

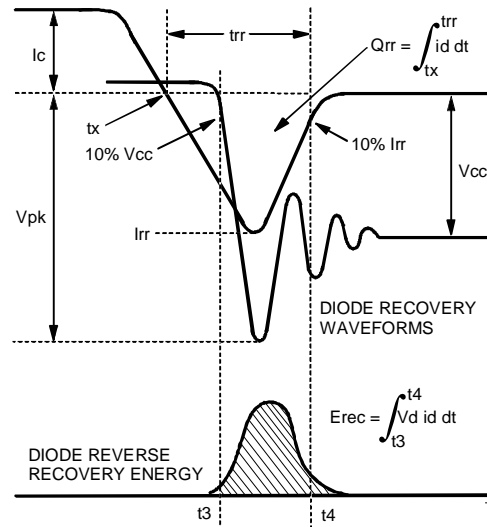


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

Refer to **Section D** for the following:
Appendix D: Section D - page D-6

- Fig. 18e - Macro Waveforms for Test Circuit of Fig. 18a
- Fig. 19 - Clamped Inductive Load Test Circuit
- Fig. 20 - Pulsed Collector Current Test Circuit



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